

HABITS OF PARASITIC HYMENOPTERA, II.

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LYSIPHLEBUS CERASAPHIS (FITCH). Plate II.

DESCRIPTION.

THIS parasite "is black with its palpi or feelers and legs pale yellowish brown; antennæ almost as long as the body, 18-jointed, the third and following joints equal, cylindrical, thrice as long as broad, the last elongated ovate; abdomen elliptic, rather narrower and shorter than the thorax, scarcely pedicelled at its base, shining, tinged with brownish; wings pellucid, stigma smoky white. Length, 0.07." (Fitch's First Annual Report.)

HABITS AND LIFE-HISTORY.

Copulation occurs soon after emergence, and the method of approach and action is precisely that described in *Lysiphlebus* sp. The female seeks her prey, *Siphonophora rosæ*, and deposits her eggs in much the same manner as *Lysiphlebus* sp. (*tritici*), except that in seven instances out of ten she was seen to bring the tip of her abdomen under her body before she was within half an inch of the aphid. If for some reason the aphid becomes aware of the parasite's presence and begins to move, the parasite will stop and apparently watch the aphid, and just as soon as it becomes quiet the *Lysiphlebus* will thrust her ovipositor into the body of the aphid and then go on in search of another. In one instance a large aphid, upon being disturbed by the parasite, kept jerking her body from side to side for eleven minutes, and during all this time the parasite waited. While the parasite is watching an aphid the antennæ are not touching the leaf but pointing toward the louse and held perfectly rigid. (Plate II.)

About three days after the aphid is parasitized it stops reproducing, and if examined closely the abdomen is seen to be slightly enlarged, and in two more days a brownish object inside is perceptible. This at the end of the eighth day resembles a crescent in shape and shows very plainly through the wall of the now swollen abdomen. Soon the abdomen begins to turn brown, and two days later the louse becomes attached firmly to the leaf or stem. By this time the body of the parasitized aphid is swollen until it is almost round, light brown in color, and the skin hard and horny in appearance. In five or six days more the parasite is ready to

leave its host. It then cuts out a neat circular piece near the caudal end of the body and emerges head first.

The writer first found this parasite at Manhattan, Kan., November 17, 1907, in Mr. Moore's east greenhouse. The infestation of aphids in this house was found to range from three to four on each rose plant. In another house about 100 yards west the infestation was so great that parts of the rose plants were covered with lice. On inquiry it was found the same methods and same preparation were used for fumigating both houses. In the house without the parasite Mr. Moore found it necessary to fumigate at least once every week, while in the other he fumigated only once every month, and then more as a precaution than as a remedy. His reason for the difference in the apparent killing power of the smoke in the two houses was that the west house, being more open, did not retain the smoke long enough to kill the aphids; the other, being less open, retained the smoke much longer. Careful examination of the west house revealed no signs of the parasite.

On December 2 five females and two males of *Lysiphlebus cerasaphis* which had not been seen in copulation were introduced. The females began at once to sting the aphids, but no signs of parasitism appeared until January 6, 1908. From this time on the parasite increased in numbers very rapidly, so that by April 1 the percentage of unparasitized aphids was exceedingly small. The number of both parasitized and unparasitized aphids on ten leaflets were counted with the following result:

Number of leaflet	1	2	3	4	5	6	7	8	9	10	Totals.
Number of parasitized aphids.....	17	6	9	1	6	13	8	5	14	6	84
Number of unparasitized aphids.....	3	1	0	2	3	0	0	1	2	0	12

Percentage of aphids parasitized, 87.3.

By May 25 it was almost impossible to find any unparasitized aphids in this house, and Mr. Moore said he had not "smoked" since the middle of March. In these observations neither temperature nor moisture records were kept.

On April 12 the *Lysiphlebus cerasaphis* was found in two greenhouses in Topeka, Kan. In these it was almost impossible to find any unparasitized aphids, while in another greenhouse in Topeka, where no signs of parasitism were found, the rose plants were very badly infested with lice. On inquiry it was found that the owners of all three houses used the same material for fumigating; but while apparently so effective in the two where the parasites were found that fumigation was unnecessary, oftener than once in three

weeks, in the one where the parasites were not found it was necessary to fumigate every week, and sometimes two evenings in succession. Even this was not sufficient to keep them under complete control.

To determine what hosts *Lysiphlebus cerasaphis* can use, fertilized females were tried on *Siphonophora rosæ* (Reaumur), the daisy aphid, *Toxoptera graminum* (Rodani), *Macrosiphum* sp., *Rhopalosiphum dianthi* (Shrank), and *Myzus persicæ* (Sulzer), but it was found that they worked only on *Siphonophora rosæ*.

EFFICIENCY.

To determine how many aphids one parasite could kill, cages were prepared, as follows: A small rose plant was set in each of five nine-inch flower pots; on each plant were placed 200 lice; the plant was then, covered by a cloth-capped lantern globe, and one pair of newly emerged parasites introduced. During the entire experiment careful moisture and maximum and minimum thermometer records were kept.

	Number of lice introduced.....	Date of lice introduction.....	Date of parasite in-production.....	Number and sex of parasites.....		Date of first fixation.....	Date of first parasite emergence.....	Date of maximum emergence.....	Number of parasites emerged.....	Number of males.....	Number of females.....	Length of time from egg to adult, days.....	Average daily mean temperature.....	Average daily moisture.....
				♂	♀									
1.....	200	5-9	5-9	1	1	5-19	5-24	5-26	52	14	38	15	75.4	72.4
2.....	200	5-9	5-9	1	1	5-20	5-25	5-26	97	32	7	16	75.3	72.4
3.....	200	5-9	5-9	1	1	5-20	5-26	5-27	61	14	47	17	73.8	73.1
4.....	200	5-9	5-9	1	1	5-20	5-25	5-26	39	36	61	16	75.3	72.4
5.....	200	5-9	5-9	1	1	5-19	5-25	5-26	105	10	95	16	75.3	72.4
Average.....									70.8	21.2	49.6	16	75.4	72.5

It was found that one fertilized female of *Lysiphlebus cerasaphis* at a mean daily temperature of 75.4 degrees F. and under a mean daily moisture of 72.5, successfully parasitized from 39 to 105 *Siphonophora rosæ*, with an average of 70.8. The length of time required for the parasite to pass from egg to adult was 16 days, with 15 to 17 days as extremes. It was also found that of the 354 parasites which emerged from this experiment, 70 per cent, or 248, were females.

To determine the rate per day of reproduction, the number produced and the length of life of *Siphonophora rosæ*, four cages were prepared, and handled as follows: In each of four six-inch flower-pots, small rose cuttings were planted, and on each was placed a young aphid born February 4, 1908; each plant was then covered by a cloth-capped lantern-globe. When the aphids began

to reproduce the young were removed every day at noon. Careful maximum and minimum thermometer records as well as moisture records were kept during the entire experiment.

Date of lice introduction.	Date when breeding began.....	Number of days from birth to maturity....	Number of young.....	Length of breeding period, days.....	Date of death.....	Length of life, days...	Mean daily temperature.....	Mean daily moisture..
2-4.....	2-17	14	26	27	3-15	41	62.7	80.8
2-4.....	2-16	13	22	48	4-4	61	63.4	73.3
2-4.....	2-15	11	88	42	3-27	53	63.8	77.9
2-4.....	3-3	28	108	58	4-2	36	63.6	78.8
Average.....		19	76	43.9		60.2	63.4	79.1

It was found that one aphid at a mean daily temperature of 63.4 degrees F. and in a mean daily moisture of 79.1, reached maturity in 16 days, with 14 and 28 days as extremes. Average number of young per day, 1.7, with an average of 76 during the reproduction period, with 26 and 108 as extremes. Average length of life, 60 days, with 41 and 86 as extremes.

RELATIVE RATE OF INCREASE.

The preceding data show the average period of reproduction of *Siphonophora rose* to be 43 days, with an average daily reproduction of 1.7. The young at the end of 16 days also begin to reproduce. It is now readily found that the progeny of a single aphid at the end of 48 days will be 1201 agamic females.

The average length of time for the parasite to pass from egg to adult has been found to be 16 days, and one fertilized female of *Lysiphlebus cerasaphis* successfully parasitized an average of 70.8 lice, 70 per cent. of which were females. From this it can be readily calculated that the total progeny at the end of 48 days or third generation would be 177,261 individuals. Theoretically the progeny of one parasite at the end of 48 days would be able to kill the progeny of 140 lice living under the same conditions.

The fact that this parasite seems unable to utilize other lice as hosts will not operate seriously against its usefulness as an enemy to the "green fly," for the reason that the green fly passes the whole year on rose plants and is a host always available.

It seems altogether probable that in this parasite we have an efficient enemy of the green fly, and possibly a method of controlling this one of the most serious insect enemies of the rose grower.

EPHEDRUS ROSÆ N. SP. Plate I.

DESCRIPTION.

Male and Female.—Length, ♂ 1.3 to 1.5 mm., ♀ 2.2 to 2.5 mm. Polished black; mandibles testaceous; palpi dark honey-yellow; legs honey-yellow; abdomen black; petiole dark honey-yellow; ovipositor brownish black. Antennæ 11-jointed;* first joint and proximal half of second black, distal half of second testaceous to honey-yellow; pedicel (one-third as long as second joint) honey-yellow, proximal half of third joint honey-yellow to testaceous, distal half of third joint and remainder of antennæ concolorous black. Wings hyaline; venation brownish; the recurrent nervure and first transverse cubitus joining in front of the second cubital cell.

HABITS AND LIFE-HISTORY.

Soon after emerging the parasites copulate and the female begins running nervously up and down the leaves and stems until she finds an aphid not parasitized. Then she throws the tip of her abdomen under her body between her legs, and with a quick forward, upward and downward thrust pushes her ovipositor through the dorsal wall into the body of the aphid, at the same time bringing her wings up as if ready to fly. It takes this parasite from fifteen to forty-five seconds to oviposit, and if the aphid begins to move during the process of oviposition, the parasite follows, keeping her ovipositor in the aphid's body until she has laid an egg. After parasitizing one aphid the parasite stops, apparently to rest, and rubs the tip of her abdomen vigorously with her hind tarsi. She then goes on in search of another victim. In no instance has the writer seen this parasite parasitize two aphids in succession without stopping and rubbing the tip of the abdomen with hind tarsi.

About three days after the aphid is parasitized it stops reproducing, and in one or two days the abdomen, if closely examined, is seen to be slightly enlarged. In another day a dark object is visible in the abdomen. This, at the end of the ninth day after the egg has been laid, resembles a crescent in shape, and shows very plainly through the wall of the swollen abdomen, which has now begun to turn black. In two more days the aphid has become attached very firmly to a leaf or some other object. By this time the body of the parasitized aphid is swollen until it is almost round; is dull black in color and the skin has a horny appearance. In eight days more the parasite is ready to leave its host. To accomplish

* The pedicel in description is not counted as a regular joint.

this it cuts a neat circular opening at the caudal end of the body, through which it promptly emerges.

DISTRIBUTION.

The writer first found these parasites at Manhattan, Kan., in Mr. Moore's greenhouse, November 11, 1907; later in two greenhouses in Topeka, Kan., April 12, 1908; and one in Lawrence, Kan., April 13, 1908. In Mr. Moore's and the two greenhouses in Topeka the *Lysiphlebus cerasaphis* was also present, while in the one at Lawrence there were no signs of *Lysiphlebus cerasaphis*, but a number of the *Ephedrus*. The lice in this house were two to every plant.

EFFICIENCY.

To find the number of aphids a single *Ephedrus* could parasitize, cages were prepared, as follows: A small rose plant was set in each of four nine-inch flower-pots; on each plant about 200 lice were placed; the plant was then covered by a cloth-capped lantern-globe and one pair of newly emerged *Ephedrus* introduced. During the entire experiment careful moisture and maximum and minimum thermometer records were kept.

Number of cage.....	Number of lice introduced.....	Date of lice introduction.....	Date of parasite introduction.....	Number and sex of parasites.....		Date of first fixation.....	Date of first parasite emergence.....	Date of maximum emergence.....	Number of parasites emerged.....	Number of males.....	Number of females.....	Length of time from egg to adult, days.....	Average daily mean temperature.....	Average daily mean moisture.....
				♂	♀									
1.....	200	5-1-9	5-9-9	1	1	5-21	5-29	5-30	19	7	12	20	75.9	73.3
2.....	200	5-6-9	5-9-9	1	1	5-22	5-31	5-1	76	44	32	22	80.0	73.6
3.....	200	5-6-9	5-9-9	1	1	5-22	5-30	5-30	31	17	14	21	75.9	73.3
4.....	200	5-6-9	5-9-9	1	1	5-20	5-29	5-30	83	28	55	20	75.9	73.3
5.....	200	5-6-9	5-9-9	1	1	5-22	5-31	6-2	57	31	26	22	81.1	73.3
Average.....									53.2	23.4	22.9	21	77.7	73.3

It was found that one fertilized female of *Ephedrus rosæ* successfully parasitized under a mean daily temperature of 77.7 degrees F., and a mean daily moisture of 73.3, from 19 to 38 *Siphonophora rosæ*, with 53.2 as an average. The length of time required for the parasite to pass from egg to adult was 21 days, with 20 to 22 days as extremes. Of the 266 parasites which emerged, 52.2 per cent., or 139, were females.

To determine what other aphids the *Ephedrus* could use for a host, fertilized females were tried on *Siphonophora rosæ* (Reaumur), the daisy aphid, *Toxoptera graminum* (Rodani), *Macrosiphum* sp., *Rhopalosiphum dianthi* (Shrank), and *Myzus persicæ* (Sulzer), but it was found they used *Siphonophora rosæ* only for a host.

RELATIVE RATE OF INCREASE.

From the preceding data on *Siphonophora rosæ* it is readily calculated that the progeny of a single louse at the end of 42 days will be 929 agamic females.

The average length of time for the *Ephedrus* to pass from egg to adult has been found to be 21 days. One fertilized female successfully parasitized an average of 53.2 lice, 50.2 per cent. of which were females. From this it is readily calculated that the total progeny at the end of 42 days would be 1529 individuals. Theoretically, the progeny of one *Ephedrus* shows an increase of 597 above the progeny of one *Siphonophora rosæ* at the end of 42 days.

Thus the parasites would be able to control the ravages of the rose "green fly." This shows to a certain extent the economic value of these parasites to the florist, for he could avoid the extra expense and labor of fumigating by introducing the *Lysiphlebus cerasaphis* and *Ephedrus* sp., which have been proven beyond a doubt to be an efficient natural check to the rose aphid under good greenhouse conditions.

In conclusion, my thanks are especially due to Dr. T. J. Headlee, under whose directions these experiments were performed and this paper written. I wish also to express my obligations to Miss H. E. Branch for the drawings, and Mr. Charles T. Brues, of Milwaukee Museum, for determining the *Lysiphlebus cerasaphis* (Fitch).

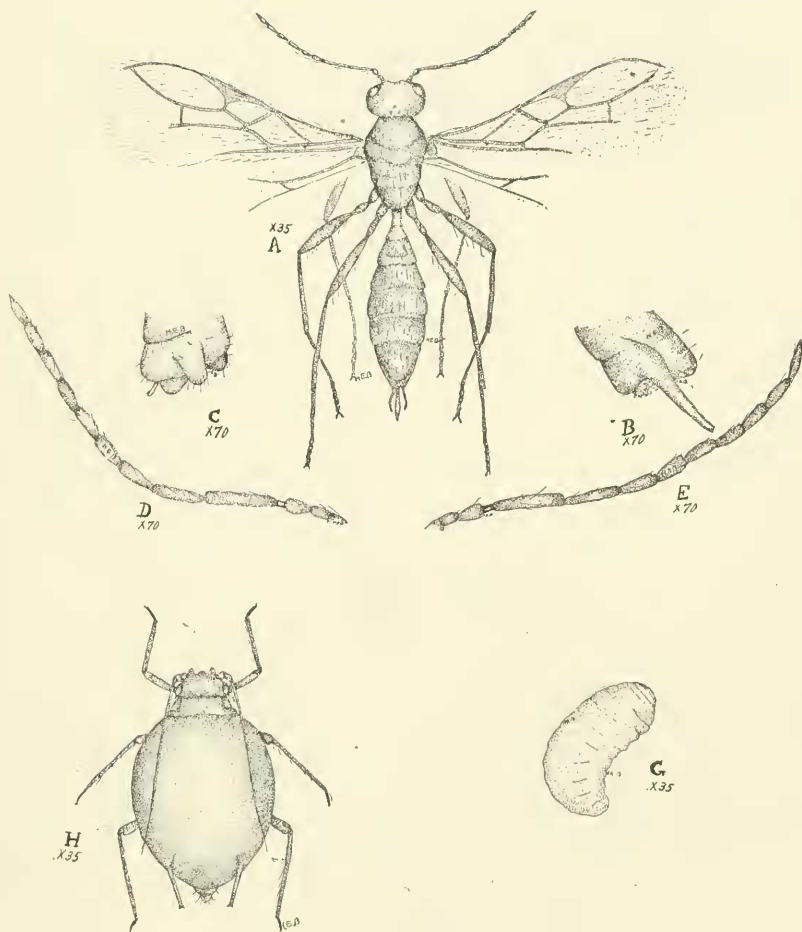


PLATE I.

Ephedrus rosæ n. sp.

- FIG. A. Dorsal view of adult female.
 " B. Tip of abdomen of female.
 " C. Tip of abdomen of male.
 " D. Antennæ of male.
 " E. Antennæ of female.
 " G. Full grown larvæ.
 " H. Aphid with parasite in pupæ state.

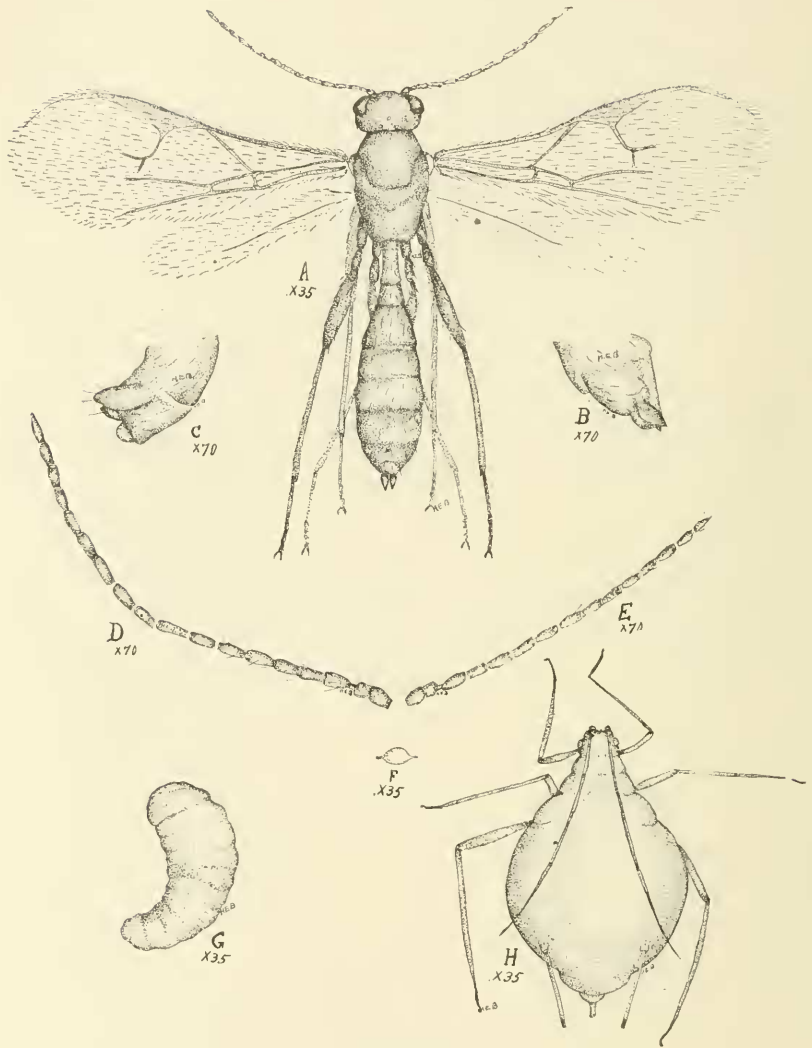


PLATE II.

Lysiphlebus cerasaphis (Fitch).

- FIG. A. Dorsal view of adult female.
 " B. Tip of abdomen of female.
 " C. Tip of abdomen of male.
 " D. Antennæ of male.
 " E. Antennæ of female.
 " F. Egg of parasite.
 " G. Full grown larvæ.
 " H. Aphid with parasite in pupæ state.